# SP6213/14

Data Sheet

Micropower 100mA CMOS LDO Regulator

## General Description

The SP6213/14 is a 100mA CMOS linear voltage regulator offered in an SC70 package that reduces board space requirements by 50% over a SOT-23 package. The SP6213/14 features low dropout voltage (250mV at 100mA), low ground current (135µA at full load) and low, 65µA quiescent current. Designed specifically for hand-held, battery-powered devices, the device includes an enable/shutdown pin. The regulator ground current increases only slightly in dropout to extend battery life. The SP6213/14 is offered in an industry standard SC70-5 package.
The SP6213/14 is available in a 3.3V fixed output voltage.

***SP6213 available, SP6214 obsolete***

The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

## Features

- Guaranteed 100mA output
- 2.5% output voltage accuracy
- Low dropout voltage: 250mV at 100mA
- Low quiescent current: 65µA
- Low ground current: 135µA at $I_L$ = 100mA
- Low shutdown current: 1µA max
- Current limit: 190mA
- Thermal shutdown: 168°C
- Good load and line regulation
- Fast transient response: $T_{ON}/T_{OFF}$ = 80µs
- Low temperature coefficient
- Unconditionally stable with 1µF ceramic
- Fixed output: 3.3V
- 100mA replacement for 80mA MIC5213 and TC1016 (SP6213)
- 100mA replacement for 80mA NCP512 (SP6214)
- Tiny SC70-5 package

## Applications

- Digital cordless phones
- Cellular phones
- PDAs
- Digital still cameras
- MP3 players
- Battery-powered equipment
- Medical devices
- Data cable

## Typical Application

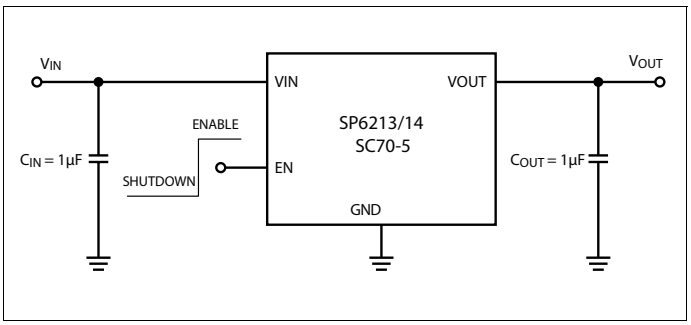


**Figure 1: Typical Application**

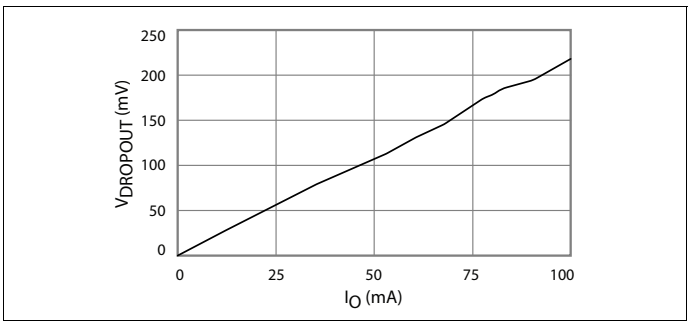


**Figure 2: Dropout Voltage vs Output Current**

# Revision History

| Revision | Release Date | Change Description |
|---|---|---|
| 241DSR00 | July 28, 2023 | **Updated:**<br>■ New template applied, contents rewriting, and obsolete packages highlighted.<br>■ Subtitle of the document.<br>■ "General Description" section.<br>■ "Features" section.<br>■ "Specifications" section.<br>■ "Mechanical Dimensions—SC70-5" figure.<br>■ "Ordering Information" section.<br>**Added:**<br>■ "Typical Application" section.<br>■ "Pin Configuration" section. |
| -- | December 13, 2005 | Legacy Sipex data sheet. |

The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

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# Specifications

***SP6213 available, SP6214 obsolete***

## Absolute Maximum Ratings

**Important:** The stresses above what is listed under the following table may cause permanent damage to the device. This is a stress rating only—functional operation of the device above what is listed under the following table or any other conditions beyond what MaxLinear recommends is not implied. Exposure to conditions above the recommended extended periods of time may affect device reliability. Solder reflow profile is specified in the *IPC/JEDEC J-STD-020C* standard. Devices are electrostatic discharge (ESD) sensitive. Handling precautions are recommended.

**Table 1: Absolute Maximum Ratings**

| Parameter | Min | Max | Units |
|---|---|---|---|
| Supply Input Voltage | –2 | 7 | V |
| Ouptut Voltage | –0.6 | ($V_{IN}$ + 1V) | V |
| Enable Input Voltage | –2 | 7 | V |
| Power Dissipation | Internally Limited (1) | | - |
| Lead Temperature (soldering 5s) | - | 260 | °C |
| Storage Temperature | –65 | 150 | °C |

1. The maximum allowable power dissipation at any $T_A$ (ambient temperature) is $P_{D\ (MAX)} = (T_{J\ (MAX)} – T_A)/\theta_{JA}$. Exceeding the maximum allowable power dissipation results in excessive die temperature and the regulator goes into thermal shutdown. The $\theta_{JA}$ of the SP6213/14 (SC70-5) is 330°C/W mounted on a PC board with minimum copper area (for more information, see "Thermal Considerations" on page 6).

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## Operating Conditions (1)

**Table 2: Operating Conditions**

| Parameter | Min | Max | Units |
|---|---|---|---|
| Input Voltage | 2.5 | 6 | V |
| Enable Input Voltage | 0 | 6 | V |
| Junction Temperature | –40 | 125 | °C |

1. The maximum allowable power dissipation at any $T_A$ (ambient temperature) is $P_{D\ (MAX)} = (T_{J\ (MAX)} – T_A)/\theta_{JA}$. Exceeding the maximum allowable power dissipation results in excessive die temperature and the regulator goes into thermal shutdown. The $\theta_{JA}$ of the SP6213/14 (SC70-5) is 330°C/W mounted on a PC board with minimum copper area (for more information, see "Thermal Considerations" on page 6).

## Thermal Specifications

**Table 3: Thermal Performance**

| Symbol | Parameter | Package | Typ | Units |
|---|---|---|---|---|
| $\theta_{JA}$ | Junction to Ambient | SC70-5 | 330 | °C/W |

# Electrical Characteristics

Electrical characteristics at $V_{IN} = V_{OUT} + 0.5V$, $I_L = 100\mu A$, $C_{IN} = 1\mu F$, $C_{OUT} = 1\mu F$, $T_J = 25°C$, unless otherwise specified. The • denotes the specifications that apply over the full temperature range of –40°C to 125°C, unless otherwise specified.

**Table 4: Electrical Characteristics**

| Parameter | Conditions | | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| Output Voltage Accuracy | Variation from specified $V_{OUT}$ | | –2.5 | - | 2.5 | % |
| | | • | –4 | - | 4 | % |
| Output Voltage Temperature Coefficient ($\Delta V_{OUT}/\Delta T$) (1) | - | | - | 60 | - | ppm/°C |
| Minimum Supply Voltage | $I_{OUT}$ = 100µA | | - | 2.50 | 2.70 | V |
| | $I_{OUT}$ = 50mA | | - | 2.55 | 2.85 | V |
| | $I_{OUT}$ = 100mA | | - | 2.75 | 3.00 | V |
| Line Regulation ($\Delta V_{OUT}/V_{IN}$) | $V_{IN}$ = ($V_{OUT}$ + 0.5V) to 6V | • | - | 0.05 | 0.2 | %/V |
| SP6213 – 1.8V Line Regulation | $V_{IN}$ = 2.8V to 6V | • | - | 0.05 | 0.2 | %/V |
| Load Regulation (2) | $I_L$ = 0.1mA to 100mA, $V_{IN}$ = $V_{OUT}$ + 1V | • | - | 0.4 | 0.8 | % |
| SP6213 – 1.8V Load Regulation | $I_L$ = 0.1mA to 100mA, $V_{IN}$ = 3.0V | • | - | 0.4 | 0.8 | % |
| Dropout Voltage ($V_{IN} – V_{OUT}$) (3) | $I_L$ = 100µA | • | - | 0.25 | 4 | mV |
| | $I_L$ = 50mA | • | - | 130 | 250 | mV |
| | $I_L$ = 100mA | • | - | 250 | 500 | mV |
| Quiescent Current | $V_{EN} \leq 0.4V$ (shutdown) | • | - | 0.01 | 1 | µA |
| | $V_{EN} \geq 1.6V$ (operating), $I_L$ = 0µA | • | - | 65 | 125 | µA |
| Ground Pin Current (4) | $V_{EN} \geq 1.6V$, $I_L$ = 100µA | • | - | 65 | 125 | µA |
| | $V_{EN} \geq 1.6V$, $I_L$ = 50mA | • | - | 100 | 175 | µA |
| | $V_{EN} \geq 1.6V$, $I_L$ = 100mA | • | - | 135 | 250 | µA |
| Power Supply Rejection Ratio (PSRR) | Frequency = 100Hz, $I_L$ = 10mA | | - | 74 | - | dB |
| | Frequency = 400Hz, $I_L$ = 10mA | | - | 40 | - | dB |
| Current Limit | - | • | 120 | 190 | 350 | mA |
| Thermal Limit | Turns on | | - | 168 | - | °C |
| | Turns off | | | 153 | - | °C |
| Thermal Regulation ($\Delta V_{OUT}/\Delta P_D$) (5) | - | | - | 0.05 | - | %/W |
| Output Noise | $I_L$ = 50mA, $C_L$ = 1µF, 10Hz to 100kHz | | - | 250 | - | $\mu V_{RMS}$ |

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**Table 4: Electrical Characteristics (Continued)**

| Parameter | Conditions | | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **Enable Input** | | | | | | |
| Enable Input Logic-Low Voltage | Regulator shutdown | • | - | - | 0.4 | V |
| Enable Input Logic-High Voltage | Regulator enabled | • | 1.6 | - | - | V |
| Enable Input Current | $V_{IL} \leq 0.4V$ | • | - | 0.01 | 1 | µA |
| | $V_{IH} \geq 1.6V$ | • | - | 0.01 | 1 | µA |
| Turn-on Time | $I_{OUT}$ = 50mA | | - | 80 | 165 | µS |
| Turn-off Time | $I_{OUT}$ = 100µA | | - | 80 | 175 | µS |
| | $I_{OUT}$ = 100mA | | - | 30 | 35 | µS |

1. Output voltage temperature coefficient is defined as the worst-case voltage change divided by the total temperature range.

2. Load regulation is measured at constant junction temperature using low duty cycle pulse testing. Parts are tested for load regulation in the load range. Changes in output voltage due to heating effects are covered by the thermal regulation specification.

3. Dropout voltage is defined as the input-to-output differential at which the output voltage drops 2% below its nominal value measured at 0.5V differential. Not applicable to output voltages less than 2.7V.

4. Ground pin current is the regulator quiescent current. The total current drawn from the supply is the sum of the load current plus the ground pin current.

5. Thermal regulation is defined as the change in output voltage at a time t after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a 100mA load pulse at $V_{IN}$ = 6V for t = 10ms.

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# Pin Information

***SP6213 available, SP6214 obsolete***

## Pin Configuration

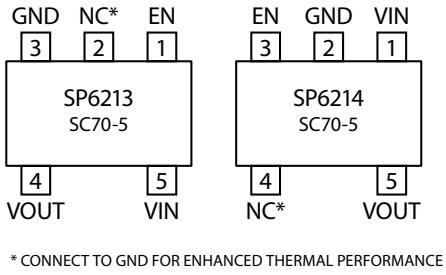


**Figure 3: SP6213/14 Pinout (Top View)—SC70-5 Package**

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## Pin Description

**Table 5: Pin Description**

| Pin Number | Pin Name | Description |
|---|---|---|
| | | **SP6213** |
| 1 | EN | Enable/shutdown (logic high = enable, logic low = shutdown). |
| 2 | NC | No connection. |
| 3 | GND | Ground connection. |
| 4 | VOUT | Regulator output. |
| 5 | VIN | Supply input. |
| | | **SP6214** |
| 1 | VIN | Supply input. |
| 2 | GND | Ground connection. |
| 3 | EN | Enable/shutdown (logic high = enable, logic low = shutdown). |
| 4 | NC | No connection. |
| 5 | VOUT | Regulator output. |

# Block Diagram

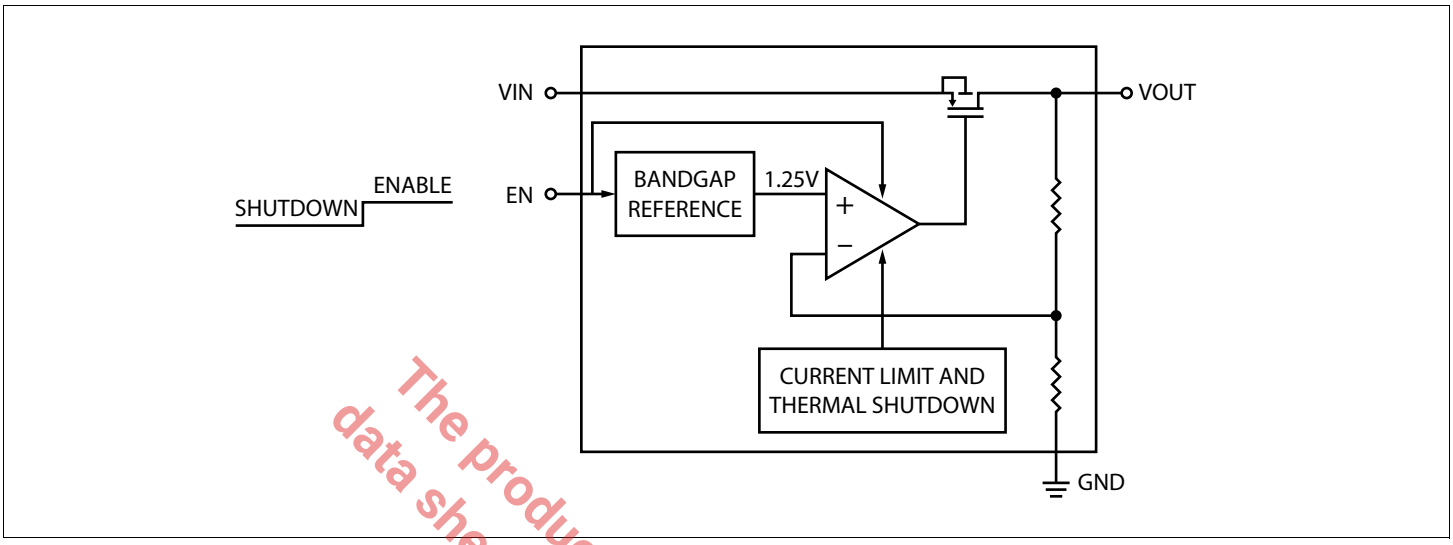


**Figure 4: Functional Block Diagram**

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# Application Information

***SP6213 available, SP6214 obsolete***

## Enable/Shutdown Operation

The SP6213/14 is turned off by pulling the EN pin low and turned on by pulling it high. If this enable/shutdown feature is not required, EN should be tied to $V_{IN}$ to keep the regulator output on at all times.

## Input Capacitor

You can use any good quality ceramic or tantalum capacitor at the input. A small capacitor of about 1µF is required from $V_{IN}$ to GND if, for instance, a battery is used as the input.

## Output Capacitor

An output capacitor is required between $V_{OUT}$ and GND to prevent oscillation. The minimum size of the output capacitor is a 0.47µF ceramic. The values given in the data sheet relate to an IC with a ceramic output capacitor of 1µF. Larger values make the IC more stable, which means an improvement of the regulator's transient response.
For a lower output current, the output capacitance can be chosen smaller in order to have the same output stability.

## No Load Stability

The SP6213/14 remains stable and in regulation with no external load (other than the internal voltage driver), unlike many other voltage regulators. This is especially important in CMOS RAM keep-alive applications.

## Thermal Considerations

The SP6213/14 is designed to provide 100mA of continuous current in a very tiny package. Maximum power dissipation can be calculated based on the output current and the voltage drop across the part. To determine the maximum power dissipation of the package, use the junction-to-ambient thermal resistance of the device and the following basic equation:

$$P_D = (T_{J(MAX)} - T_A)/\theta_{JA}$$

$T_{J(MAX)}$ is the maximum junction temperature of the die and is 125°C. $T_A$ is the ambient operating temperature. $\theta_{JA}$ is the junction-to-ambient thermal resistance for the regulator and is layout-dependent. The actual power dissipation of the regulator circuit can be determined using one simple equation:

$$P_D = (V_{IN} - V_{OUT})*I_{OUT} + V_{IN}*I_{GND}$$

Substituting $P_{D(MAX)}$ for $P_D$ and solving for the operating conditions that are critical to the application gives the maximum operating conditions for the regulator circuit. For example, if you are operating the SP6213/14 at 3.0V output at room temperature, with a minimum footprint layout, the maximum input voltage for a set output current can be determined as follows:

$$P_{D(MAX)} = [(125°C - 25°C)/(330°C/W)] = 303mW$$

To prevent the device from entering thermal shutdown, the maximum power dissipation cannot be exceeded. Using the output voltage of 3.0V and an output current of 100mA, the maximum input voltage can be determined. You can find the ground pin current values in "Electrical Characteristics" on page 2 (0.135mA at 100mA load current).

The maximum input voltage is determined as follows:

$$303mW = (V_{IN} - 3.0V)*100mA \text{ load current} + V_{IN}*0.135mA$$

Calculations show that the maximum input voltage of a 3.0V application at 100mA of output current in an SC70-5 package is 6.02V.

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# Typical Performance Characteristics

27°C, $V_{IN}$ = 4V, $I_L$ = 100µA, $C_{IN}$ = $C_{OUT}$ = 1µF, unless otherwise specified.

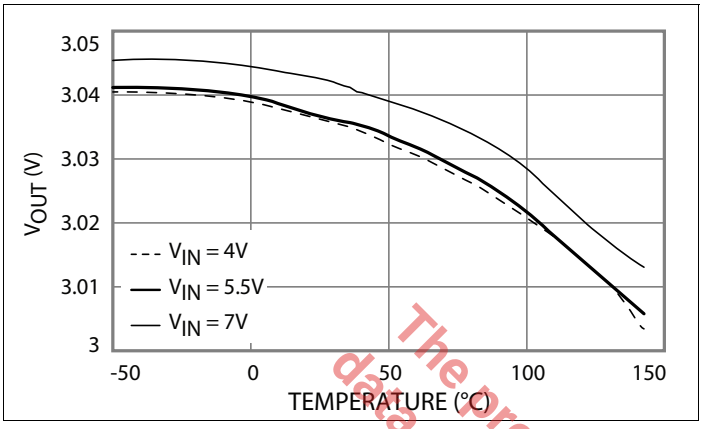



**Figure 5: Output Voltage vs Temperature ($I_{OUT}$ = 0.1mA)**

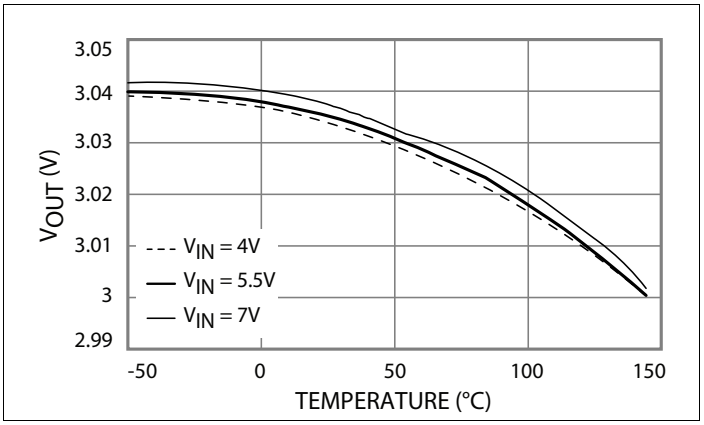



**Figure 6: Output Voltage vs Temperature ($I_{OUT}$ = 10mA)**

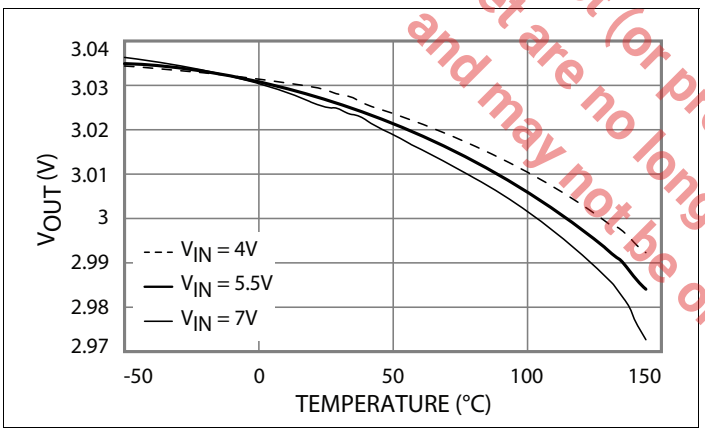



**Figure 7: Output Voltage vs Temperature ($I_{OUT}$ = 50mA)**

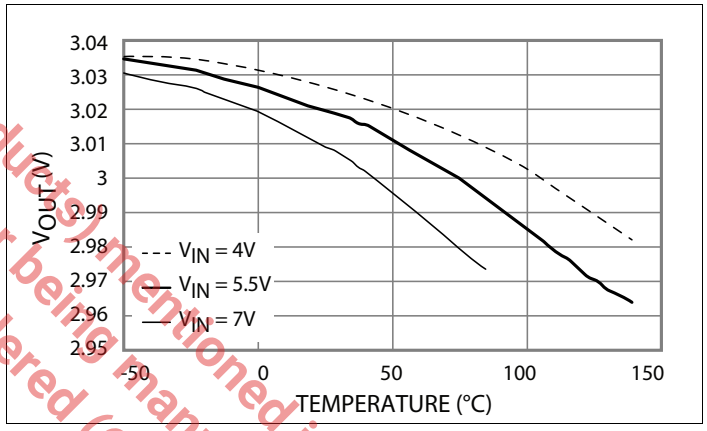



**Figure 8: Output Voltage vs Temperature ($I_{OUT}$ = 100mA)**

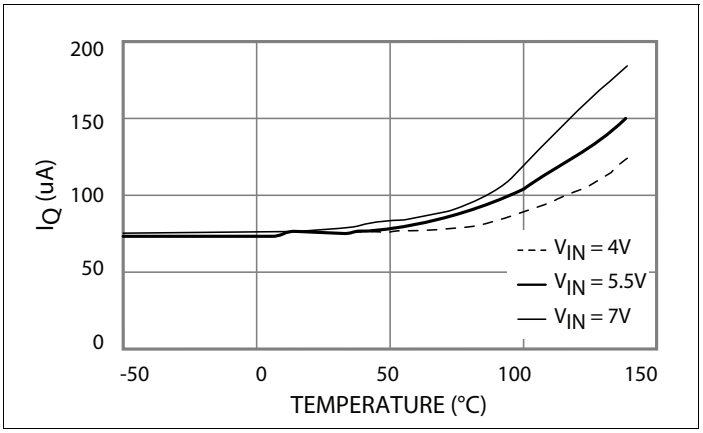



**Figure 9: Quiescent Current vs Temperature ($I_{OUT}$ = 0A)**

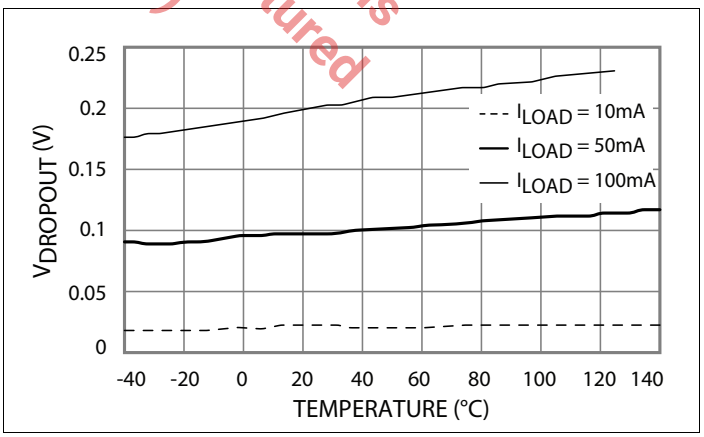



**Figure 10: Dropout Voltage vs Temperature**

The product (or product(s) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

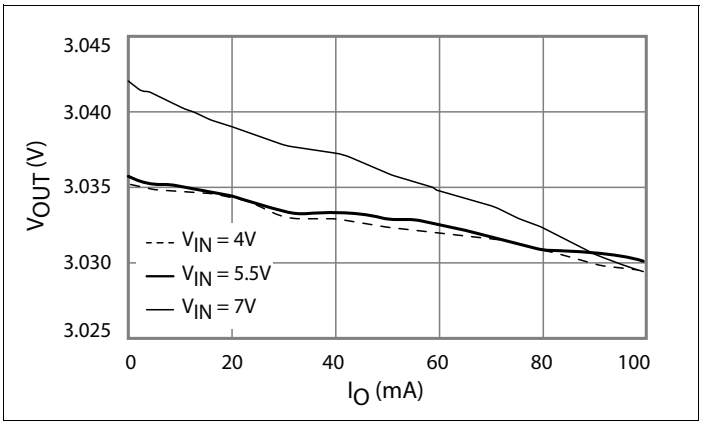



**Figure 11: Output Voltage vs Output Current**

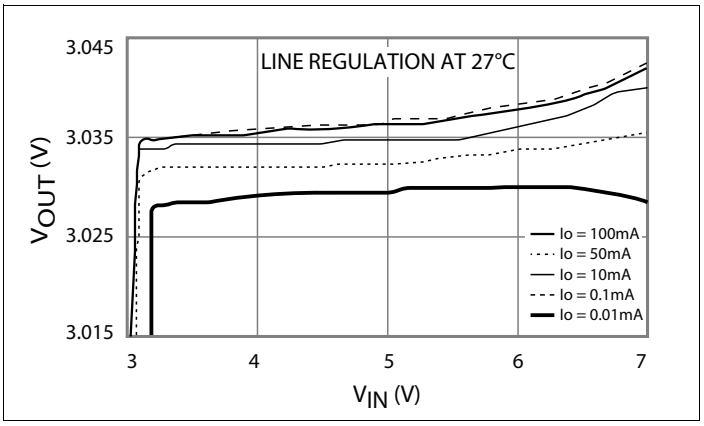



**Figure 12: Output Voltage vs Input Voltage**

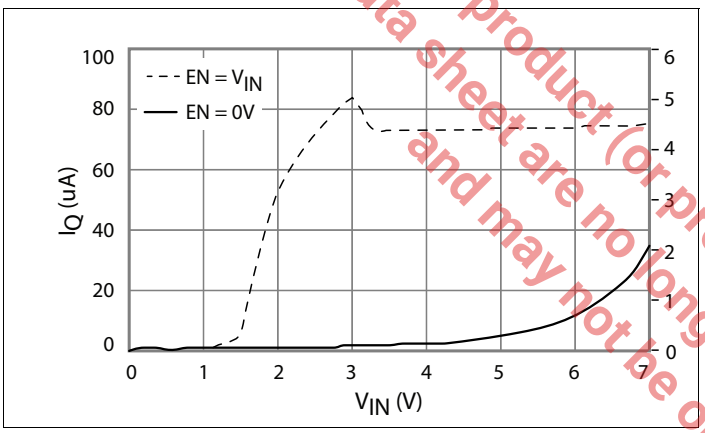



**Figure 13: Quiescent Current vs Input Voltage**

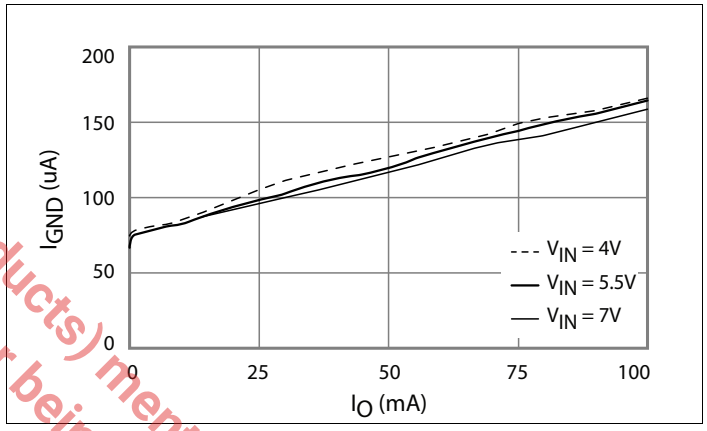



**Figure 14: Ground Current vs Output Current**

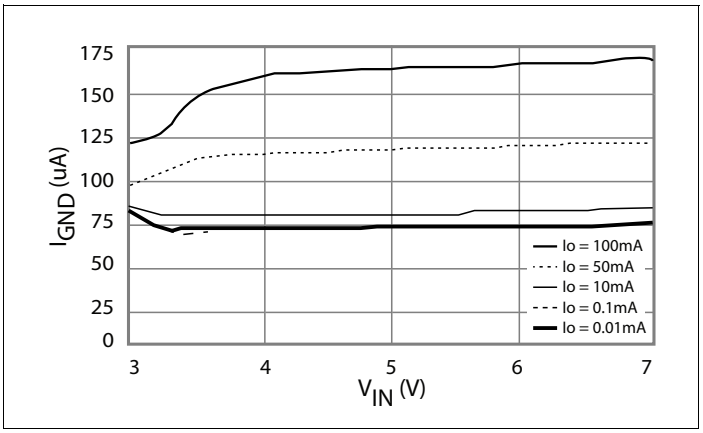



**Figure 15: Ground Current vs Input Voltage**

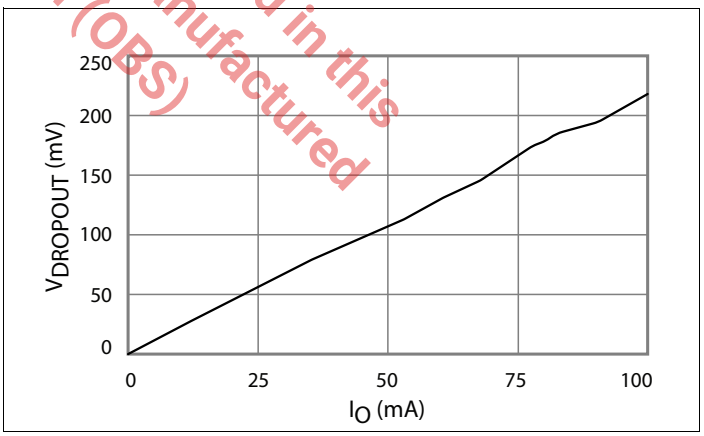



**Figure 16: Dropout Voltage vs Output Current**

The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

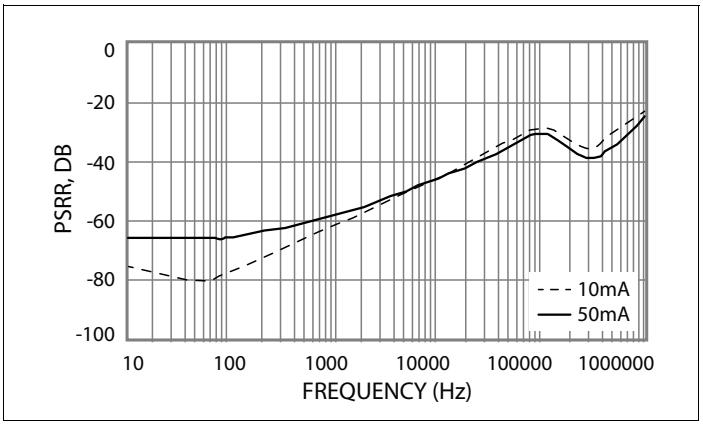



**Figure 17: Power Supply Rejection Ratio ($V_O$ = 3V)**

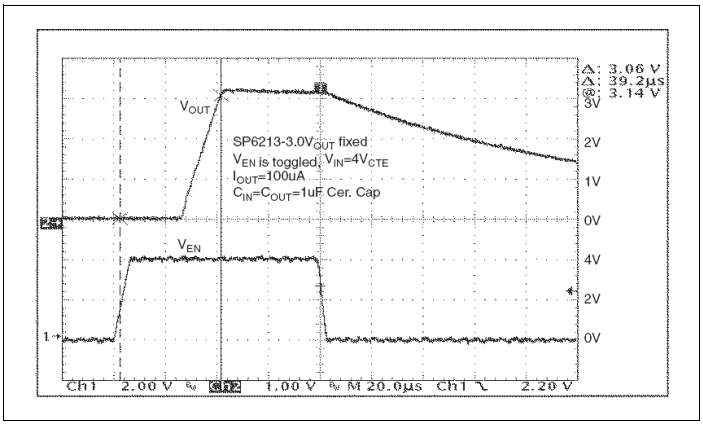



**Figure 18: Turn-on Characteristic ($V_{IN}$ = 4V, $I_{OUT}$ = 100µA)**

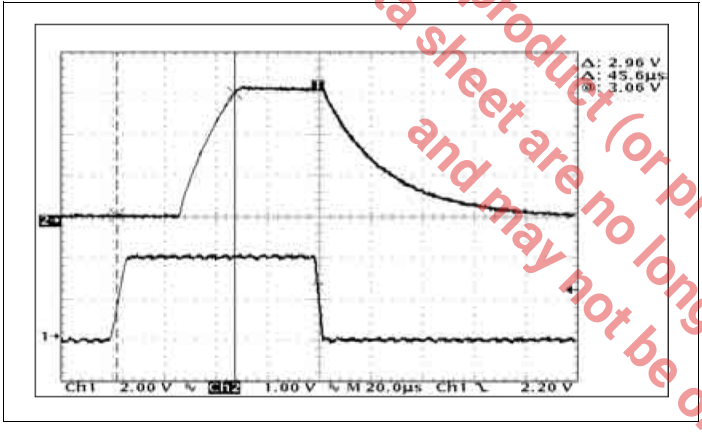



**Figure 19: Turn-on Characteristic ($V_{IN}$ = 4V, $I_{OUT}$ = 100mA)**

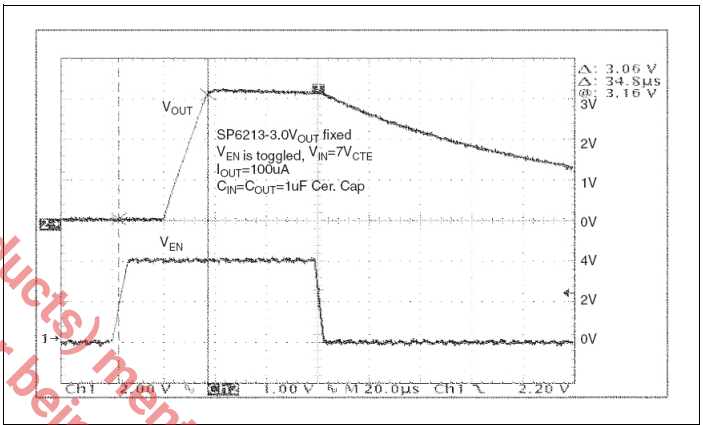



**Figure 20: Turn-on Characteristic ($V_{IN}$ = 7V, $I_{OUT}$ = 100µA)**

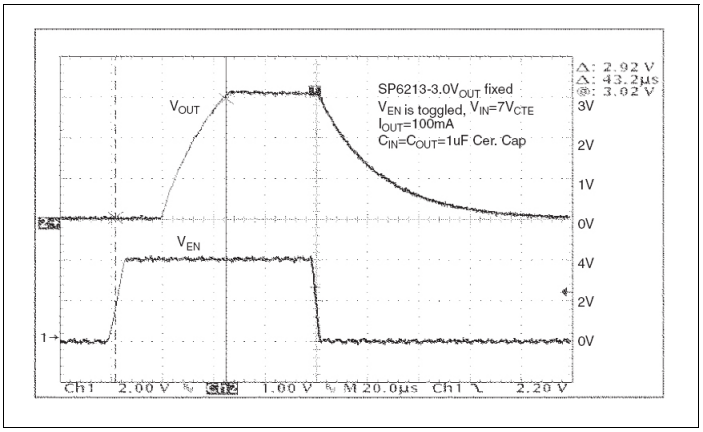



**Figure 21: Turn-on Time ($V_{IN}$ = 7V, $I_{OUT}$ = 100mA)**

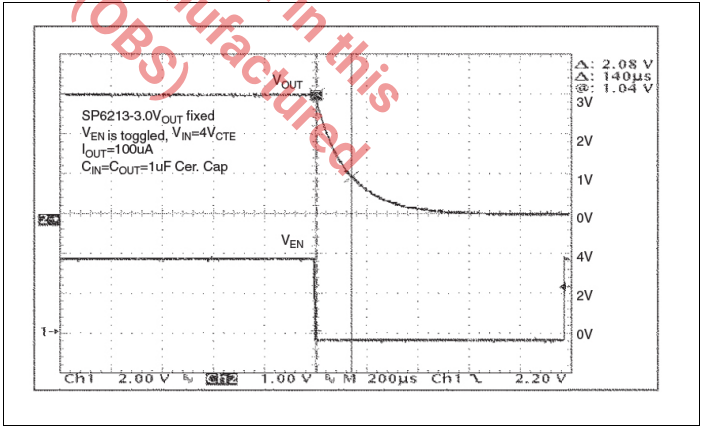



**Figure 22: Turn-off Time ($V_{IN}$ = 4V, $I_{OUT}$ = 100µA)**

The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

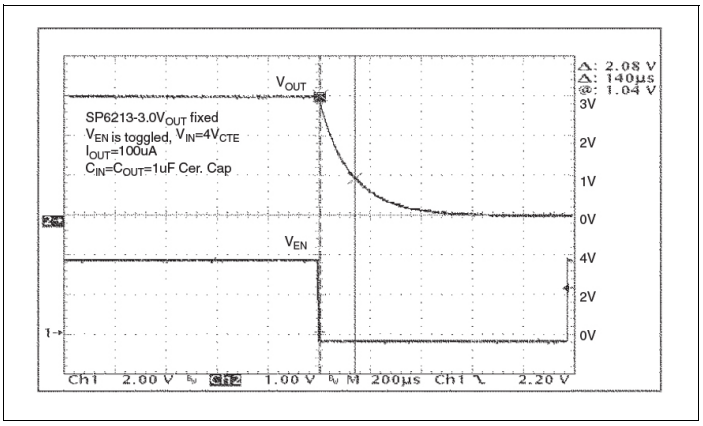



**Figure 23: Turn-off Time ($V_{IN}$ = 4V, $I_{OUT}$ = 100mA)**

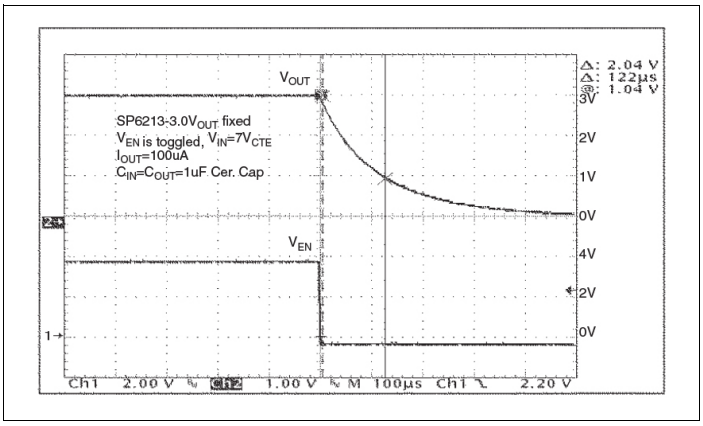



**Figure 24: Turn-off Time ($V_{IN}$ = 7V, $I_{OUT}$ = 100µA)**

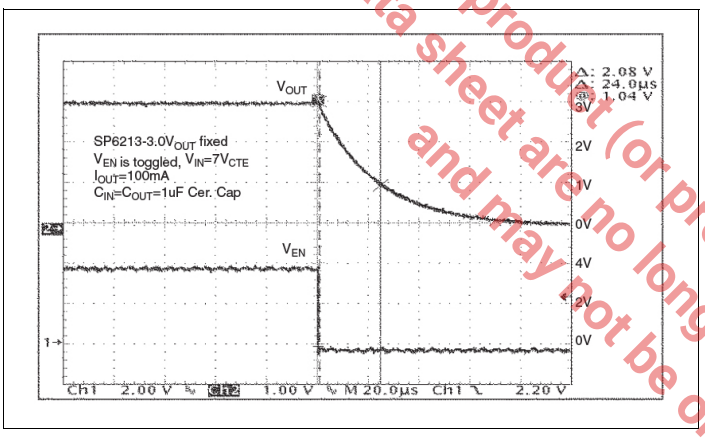



**Figure 25: Turn-off Time ($V_{IN}$ = 7V, $I_{OUT}$ = 100mA)**

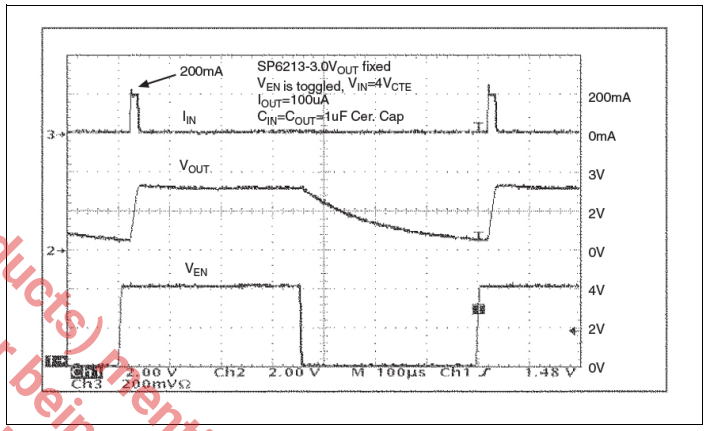



**Figure 26: Inrush Current ($V_{IN}$ = 4V, $I_{OUT}$ = 100µA)**

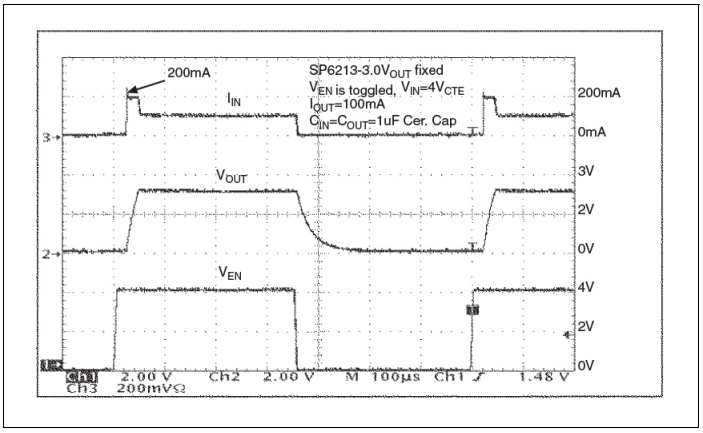



**Figure 27: Inrush Current ($V_{IN}$ = 4V, $I_{OUT}$ = 100mA)**

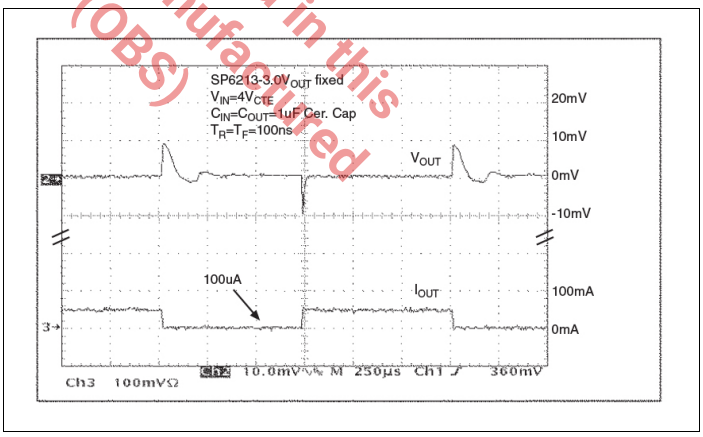



**Figure 28: Load Transient Response ($V_{IN}$ = 4V)**

The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

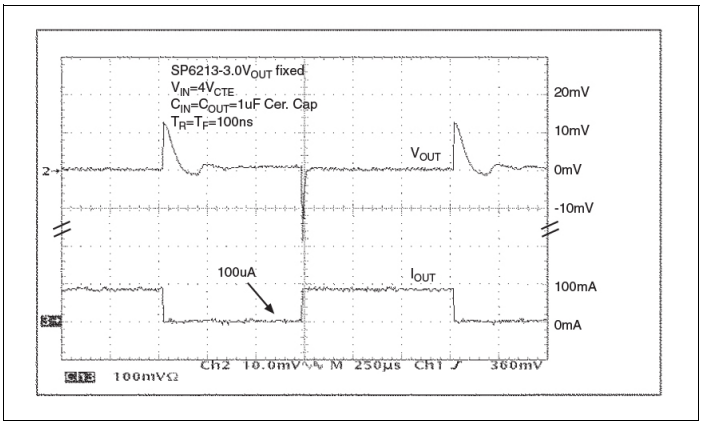



**Figure 29: Load Transient Response ($V_{IN}$ = 4V)**

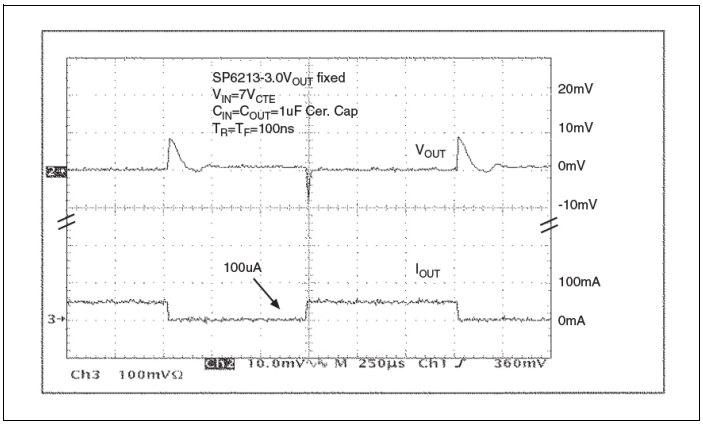



**Figure 30: Load Transient Response ($V_{IN}$ = 7V)**

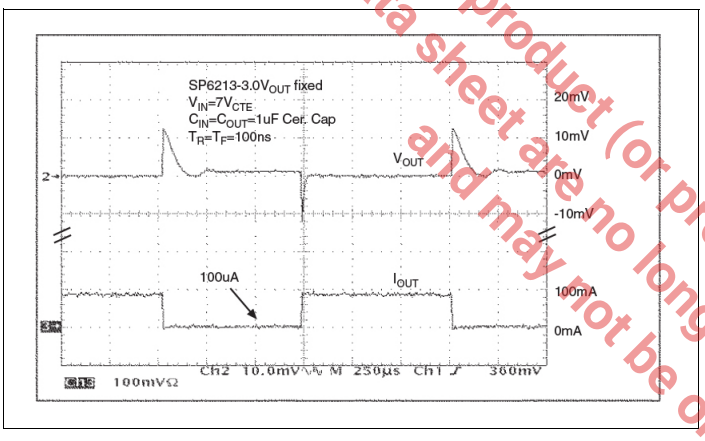



**Figure 31: Load Transient Response ($V_{IN}$ = 7V)**

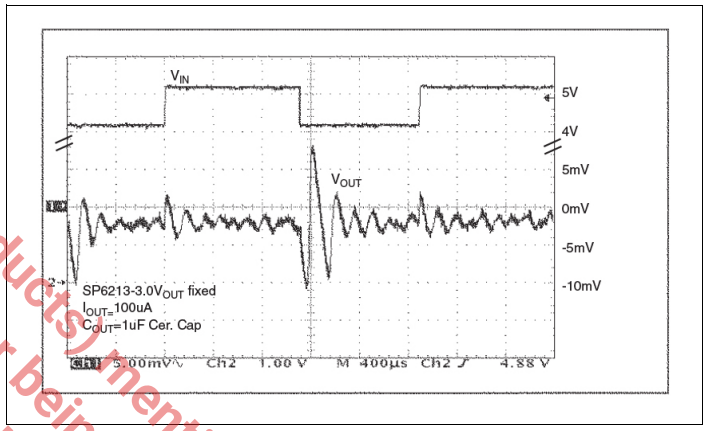



**Figure 32: Line Transient Response ($V_{IN}$ = 4V, $I_{OUT}$ = 100µA)**

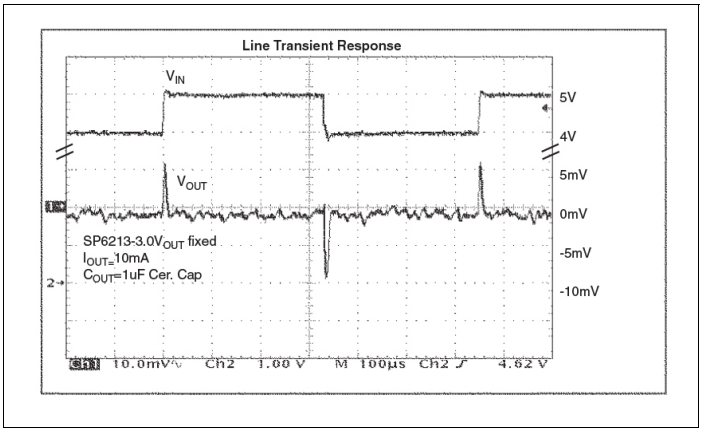



**Figure 33: Line Transient Response ($V_{IN}$ = 4V, $I_{OUT}$ = 10mA)**

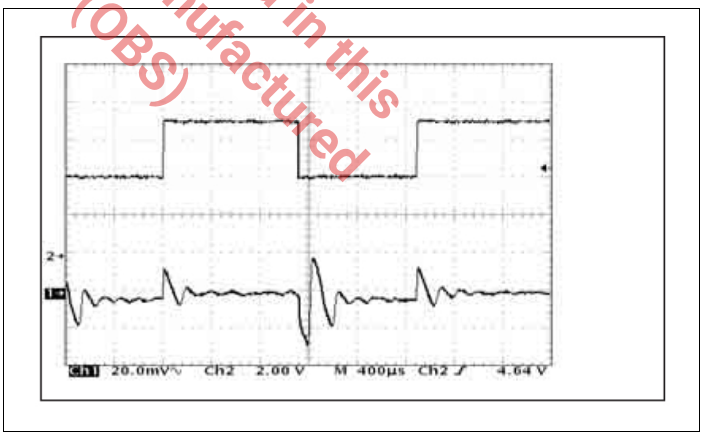



**Figure 34: Line Transient Response ($V_{IN}$ = 7V, $I_{OUT}$ = 100µA)**

The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

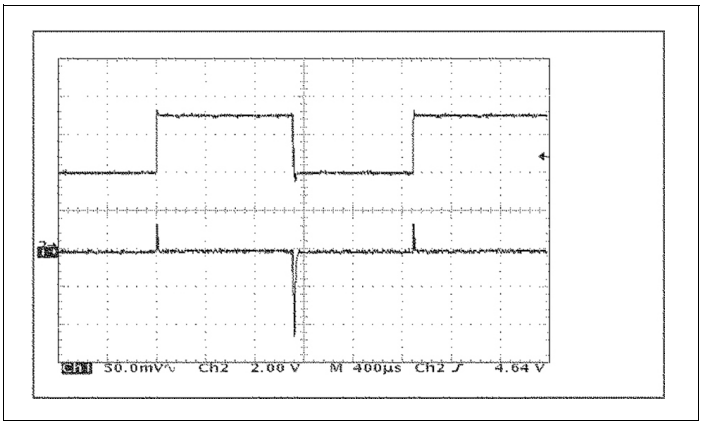


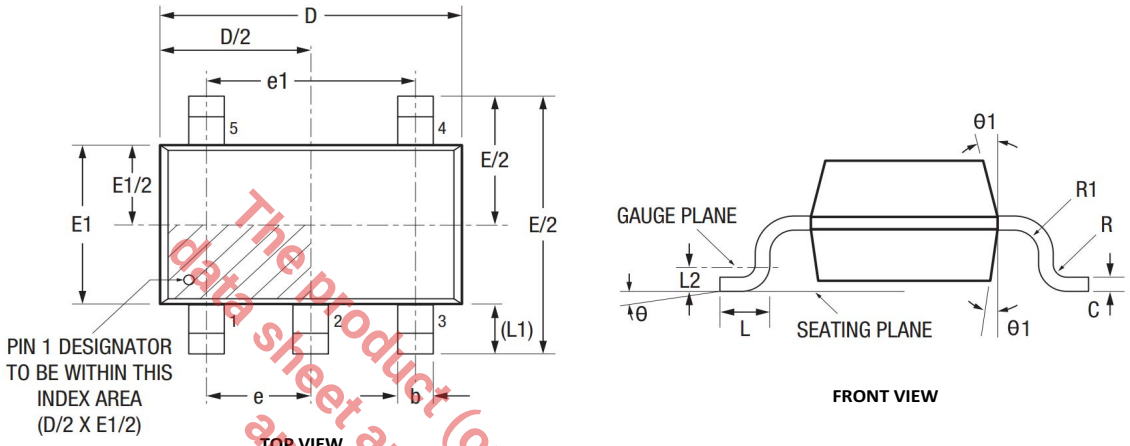

**Figure 35:** Line Transient Response ($V_{IN}$ = 7V, $I_{OUT}$ = 10µA)

The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

# Mechanical Dimensions

## SC70-5

***SP6213 available, SP6214 obsolete***




The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

| 5-Pin SC70 (JEDEC MO-203) Variation AA | | | | | | |
|---|---|---|---|---|---|---|
| Symbols | Dimension in mm (Control Unit) | | | Dimension in inches (1 inch = 25.40mm) | | |
| | Min | Nom | Max | Min | Nom | Max |
| A | - | - | 1.10 | - | - | 0.043 |
| A1 | 0.00 | - | 0.10 | 0.000 | - | 0.004 |
| A2 | 0.70 | 0.90 | 1.00 | 0.028 | 0.036 | 0.039 |
| c | 0.08 | - | 0.22 | 0.004 | - | 0.009 |
| D | 2.00 BSC | | | 0.079 BSC | | |
| E | 2.10 BSC | | | 0.083 BSC | | |
| E1 | 1.25 BSC | | | 0.049 BSC | | |
| L | 0.26 | 0.36 | 0.46 | 0.011 | 0.014 | 0.018 |
| L1 | 0.42 Ref | | | 0.017 Ref | | |
| L2 | 0.15 BSC | | | 0.006 BSC | | |
| R | 0.10 | - | - | 0.004 | - | - |
| R1 | 0.10 | | 0.25 | 0.004 | - | 0.01 |
| θ | 0° | 4° | 8° | 0° | 4° | 8° |
| θ1 | 4° | - | 12° | 4° | - | 12° |
| b | 0.15 | - | 0.30 | 0.006 | - | 0.012 |
| e | 0.65 BSC | | | 0.026 BSC | | |
| e1 | 1.30 BSC | | | 0.051 BSC | | |

Drawing No.: POD-00000177
Revision: A

**Figure 36: Mechanical Dimensions—SC70-5**

# Ordering Information

***SP6213EC3 and SP6214 obsolete***

**Table 6: Ordering Information**

| Ordering Part Number | Operating Temperature Range | Accuracy | Output Voltage | Package | Packaging |
|---|---|---|---|---|---|
| SP6213EC5-L-3-3/TR | $-40°C \le T_J \le 125°C$ | 2% | 3.3V | SC70-5 | Tape and Reel |

**Note:** For more information about part numbers, as well as the most up-to-date information and additional information on environmental rating, go to www.maxlinear.com/SP6213 and www.maxlinear.com/SP6214.

The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS).

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